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(54) Hub for optical disk and optical disk.

(57) The present invention relates to hubs (67) for optical disks (61) in which a lubricant layer is formed on or in the vicinity of an opening edge (100) into which a spindle (93) of the optical disk driving device (91) is inserted, and optical disks (61) in which the above-mentioned hubs (67) are used. By using the optical disks (61) provided with such hubs (67) as mentioned above, sliding properties between the spindle (93) of the disk drive (91) and the center hole (100) of the hub (67) are markedly improved, and excellent loading performance of the optical disk (61) is accomplished.

EP 0 488 388 A2

FIELD OF THE INVENTION

This invention relates to hubs for optical disk and optical disks having said hubs, and more particularly the invention relates to hubs for optical disk and optical disks having said hubs, both of them being so designed that when a spindle of the optical disk driving device is fitted into the hub of the optical disk, excellent lubricating properties or slipping properties can be exhibited between the spindle and a center hole of the hub, and no poor loading performance is produced.

BACKGROUND OF THE INVENTION

Because of their characteristics such as large memory capacity and portability, optical disks have a future possibility of being used in a great variety of applications, and in recent years extensive researches and developments of the optical disks have been conducted.

Optical disks which have been made fit for practical use include those of read-only type such as a compact disk (CD) and CD-ROM, and those of the write-once type capable of storing information but incapable of erasing the stored information. Further, practical use of the rewritable optical disks is begun.

Such optical disks as mentioned above are usually held rotatably in a thin flat case, and are often used as optical disk cartridges.

When this optical disk cartridge is set on a carriage of a recording and reproducing equipment, a spindle of a disk drive is fitted with a hub of the optical disk. In this case, the spindle is so designed that it is inserted into a center hole of the hub.

Thereafter, the surface of the optical disk exposed through the cartridge is irradiated with a laser beam, whereby information is recorded in the disk or the recorded information is reproduced therefrom.

In such cases, however, the spindle sometimes cannot be inserted smoothly into the center hole of the hub, or frictional force produced between the surface of the spindle and the inner peripheral surface of the center hole of the hub becomes large. As the result, the spindle is damaged sometimes when the center hole of the hub is made of a metal, or when the center hole of the hub is made of a resin, lubricating properties between the spindle and the center hole of the hub become poor depending on the kind of resin used, whereby a poor loading performance is sometimes produced.

OBJECT OF THE INVENTION

The present invention has been made in view of the circumstances as mentioned above, and an object of the invention is to provide hubs for optical disk and optical disks having said hubs, both of them being so designed that when a spindle of the optical disk driving device is fitted into the hub of the optical disk, improved sliding properties or slipping properties can be exhibited between the spindle and a center hole of the hub, whereby an excellent loading performance is exhibited.

SUMMARY OF THE INVENTION

The hubs for optical disk of the present invention having a center hole into which a spindle of an optical disk driving device is inserted, are characterized in that a lubricant layer is provided in an opening edge of the center hole of the hub or in the vicinity of said opening edge.

The optical disks of the present invention are characterized in that said disks are provided with a hub having a center hole into which a spindle of an optical disk driving device is inserted, said hub being provided with a lubricant layer in an opening edge of said center hole of the hub or in the vicinity of said opening edge.

The lubricant layer used in the hub of the optical disk includes suitably those formed from lubricants, preferably from silicone oil, silicone grease or silicone oil compound, and preferably having a thickness of from 1 to 50,000 Å.

In the present invention, the lubricant layer is provided in the opening edge of the center hole of the hub or in the vicinity of said opening edge, for example, by applying the lubricant thereto, hence sliding properties or slipping characteristics are improved at the time when the spindle is inserted into the center hole of the hub, thereby preventing the spindle or hub from its damage.

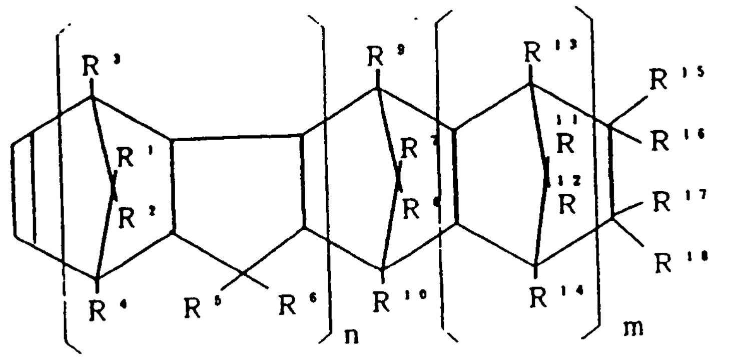
It has been found by an experiment 20,000 times on loading an upright drive with the optical disk of the invention that the sliding properties between the spindle and the center hole of the hub was excellent and no spin-up troubles occurred.

The disk substrates 63 comprises a resin substrate 63a and a recording medium layer 63b laminated on one (inner) side of said disk substrate 63. In this embodiment of the invention, the disk substrates 63 both respectively have the recording medium layers 63b thereon, but the recording medium layer 63b may be formed only on one of the disk substrates 63.

The resin substrate 63a may be formed from any resinous materials known hitherto, for example, resins commonly used as substrate materials such as polymethyl methacrylate and polycarbonate, and random copolymers of ethylene with cycloolefins such as tetracyclododecene, methylcyclotetradodecene and norbornene.

Desirable materials for the substrate used in the present invention are resins having an intrinsic viscosity [η] of 0.05 - 10 dl/g, such as (a) cycloolefin random copolymers of ethylene and a cycloolefin represented by the following formula [1] and (b) polyolefins comprising polyolefins formed by ring opening polymerization of the cycloolefin represented by the following formula [1] or hydrogenation products of the polyolefins.

General formula [1]



... [1]

wherein n is 0 (zero) or 1, m is 0 (zero) or a positive integer, R^1 - R^{18} are individually hydrogen, halogen or hydrocarbon group. R^{15} - R^{18} may, linking together, form a mono- or polycyclic, and R^{15} with R^{16} or R^{17} with R^{18} may form a divalent hydrocarbon group. The mono- or polycyclic composed of R^{15} - R^{18} may have double bond.

The recording medium layer 63b comprises a recording material layer or, if necessary, a laminate including one or two or more layers selected from among a protective layer comprising inorganic or organic materials (e.g. SiNx, ultraviolet curing resin, etc.), enhancing layer, reflecting layer, good heat conductive layer (e.g. Al alloy), interference layer and reflection preventing layer, which are laminated on the recording material layer and/or on the reverse of said recording material layer, or alternatively the recording medium layer 63 preferably comprises the recording material layer laminated with the protective layer comprising the organic material (e.g. ultraviolet curing resin) or the inorganic material as the outermost layer. Particularly, it is preferable that on the substrate 63a is laminated the recording medium layer 63b comprising a SiN protective layer/recording material layer/SiN protective layer/Al alloy layer/ultraviolet curing resin layer in this order. The recording material layer may be formed from any materials so long as they are optical recording materials, including those used exclusively for replay such as a compact disk (CD) and CD-ROM, for those of the write-once type capable of storing information but incapable of erasing stored information or those for the rewritable type. In addition, there may be mentioned, for example, magnetooptical recording materials containing a 3d transition metal and rare-earth elements such as Tb Fe Co or containing 3d transition metal, rare-earth metal and corrosion resistant metal such as Tb Fe Co plus Pt or Pd; organic coloring materials such as cyanine and naphthalocyanine dyes; low melting metallic materials such as Te, Te-C-H and Te-Cr-C-H; or disk substrates having formed thereon pits corresponding to signals. Of these recording material layers mentioned above, particularly preferred are magnetooptical recording material layers.

The disk substrates 63 are bonded together by means of an adhesive layer 68c as shown in Fig. 1 (or Fig. 6), or joined together through an outer peripheral spacer 68a and an inner peripheral spacer 68b by means of an adhesive or ultrasonic welding (air-sandwich type) as shown in Fig. 2 (or Fig. 7).

In the present invention, an adhesive for bonding the disk substrates and the hubs includes, a

inside the centering hole 651. It is desirable that an outer peripheral edge 702 of the metallic member 701 is embeded into the resin body 67b of the hub 67, and fastened to said resin body.

In the optical disk 61 of the present invention, it is desirable that an opening edge 100 of the center hole 77 of the hub 67 is chamfered (broken) as shown in Fig. 5 or 8.

The chamfered opening edge 100 includes the opening edges 100 extending in the form of an arc in the direction of opening end (in other words, being rounded off by radius: R type) as shown in Fig. 1, 2 or 10 (a), extending straight in the direction of opening end as shown in Fig. 10 (b-1), 6 or 7 and a bore diameter of said opening edge 100 is relatively <mall tapered type, for example, having chamfer of 45° or extending straight in the direction of opening end as shown in Fig. 10 (b-2) and a bore diameter of said opening edge 100 is relatively large tapered type. The opening edge 100, however, desirably is the chamfer of R type. In the present invention, in case that the opening edge of the center hole of the hub is chamfered, it becomes easy to apply the lubricant on the opening edge of the center hole or in the vicinity of said opening edge and the loading properties of the recording disks are improved since the layer of the lubricant is capable of keeping stability for a long time and the spindle is inserted smoothly.

In order to exhibit the effect obtained by the chamfer of the opening edge of the hub center hole at its maximum, in the chamfered edge of the R type, the radius thereof is preferably not more than 0.2 mm, more preferably, 0.02 to 0.2 mm, and in the tapered type, two sides crossing at right angles in a shaved sectional triangle individually has a length preferably of not more than 0.2 mm, more preferably of 0.02 to 0.2 mm.

Preparation of hub

The hub 67 used in the optical disk of the present invention may easily be prepared by insert molding technique, wherein the metallic member 67a is placed in position within a mold and a resin is then injected into the mold to obtain the desired resin body 67b.

The hub 67 having a concave portion 81 in the outward end face s6 as shown in Fig. 1 or 2 may be prepared, for example, by a process wherein a resin hub body 67b having 1 or 2 or more concave portions 81 provided at equal interval in the vicinity of the circumference of the outward end face s6 is first prepared and then the metallic member 67a having 1 or two or more engaging members 82 is fitted in the concave portions 81 of the resin hub body 67a.

Preparation of Optical Disk

The optical disk 61 shown in Fig. 1 is prepared by bonding the laminated disk substrate 63 to the hub 67, and bonding the hubs 67 to each other. The adhesive layer 83 is formed in a gap x between the central opening 65 of the disk substrate 63 and the column-like portion of the hub 67 fitted to this central opening 65, in a gap y between the circumferential portion of the central opening 65 and the flange portion 73 applied along this circumferential portion, and in a gap z between the inward end faces s7 of the hubs 67, and a groove 78 acts as a reservoir for the adhesive.

In the present invention, it is desirable to provide the groove 78 from the standpoint of adhesive force, but this groove 78 is not essential and, depending on circumstances the groove 78 may be omissible. In the present invention, it is desirable, from the standpoint of adhesion strength, to form the adhesive layer 83 at the three portions x, y and z. However, the adhesive layer 83 may be formed only at the portion y or may be formed at the portions x and y or y and z.

Lubricant layer

In the present invention, for example, in the optical disk 61, a lubricant layer (not shown) is formed in the opening edge 100 of the center hole 77 into which the tip 521a of the spindle 93 is inserted or in the vicinity of said opening edge 100. In the present invention this lubricant layer may have varying thickness depending on the kind of the lubricant used, but usually has a thickness of 1 to 50,000 Å, preferably 5 to 20,000 Å, and especially 100 to 15,000 Å, and is formed by coating a lubricant, for example, silicone grease.

In the present invention, it is desirable to use such lubricants that they are transparent, non-volatile or sparingly volatile and excellent in chemical stability, though any known lubricants may be used. Such lubricants as mentioned above include, for example, silicone oil, silicone grease (for example, silicone oil incorporated with viscosity increasing agents (thickeners) such as metallic soap, etc., and various additives such as oiliness improvers, antioxidants, etc.), silicone oil compound (a product obtained by mixing silicone

In the turn table 96, a magnet 524 is provided in order to attract the metallic plate s12 of the hub 67 in a state where the hub 67 is embraced by the annular holding portion 523 and the spindle 93 is inserted into the center hole 77, and the hub 67 is fixed on the turn table 96 by means of this magnet and this annular holding portion. When the turn table 96 is set to rotate, the optical disk rotates and the disk substrate 63 exposed through the open window 512 is irradiated with a laser beam, whereby information is recorded or reproduced in and from the optical disk.

In order to demonstrate the effect of the present invention, the present inventor conducted 20,000 times an experiment of loading the optical disk of the invention on the upright drive, whereupon no spin-up trouble occurred.

The upright drive referred to above has a disk cartridge loading aperture formed perpendicular to the ground, and the disk cartridge is inserted longitudinally into said loading aperture.

Further, the present inventor prepared the optical disk which was applied silicone grease (silicone oil compound HVG produced and sold by Toray Dow Corning Silicone K.K.) by the above-mentioned procedure to a thickness of 1 μm on the opening edge (tapered portion) 100 of each center hole of 10 optical disks (both sides make 20 faces) of Fig. 1, each of which was received in the cartridge case 510 as shown in Fig. 8, and put the optical disks thus treated were individually put to "upright loading test" 50 times per one side (both sides make 100 times), whereupon the spindle got accurately and quickly into the center hole 77 of the hub 67 in every case, the turn table of the upright drive attracted surely the hub 67 and the optical disk was set to spin up (the optical disk which is at a standstill suddenly initiates to rotate by interlocking with rotation of the turn table), whereupon no poor loading performance occurred.

In the "upright loading test" mentioned above, Sony Drive SMO-S 501 produced and sold by Sony Corporation was used as a driving device.

The present inventor conducted 25,000 times an experiment (load/unload test) to load the optical disk (see Fig. 1) on an upright drive (SMO-S 501 produced and sold by Sony Corporation), whereby no trouble occurred.

In conducting the above experiment, the load/unload test was carried out automatically using a robot (RV-CMI produced and sold by Mitsubishi Elect. Corp.).

The load/unload test referred to above is intended to mean a repetition of such loading operation as mentioned below, wherein a robot was used.

That is, the robot is allowed to insert into the upright drive the optical disk which is completely taken off from the drive, whereby the thus inserted optical disk is fitted automatically to said drive. The upright drive is then set to initiate the spin-up of the thus fitted optical disk, whereby the upright drive is brought to "READY STATE" wherein the recording and reproducing operation becomes possible, and "BUSSY LAMP" provided in said upright drive to instruct a quick rotation of the optical disk goes off. After the lamp went off, the robot is allowed to press "EJECT BUTTON" for instructing to take out the optical disk therefrom, thereupon the optical disk is ejected therefrom to appear partly. The robot is then allowed to draw out completely the partly appeared optical disk from the upright drive, whereby the test terminates one time. By "load/unload test" is meant that such a test as mentioned above is carried out repeatedly. The drive was set to sound the alarm when the drive is not brought to the "READY STATE" 15 seconds after the optical disk was inserted into the drive. The tact time for the test of one time was 22 seconds.

Such a load/unload test as mentioned above was conducted 25,000 times, whereupon no trouble such as poor loading performance occurred at all. No trouble was observed in the hub portion when the hub portion was inspected visually in the middle of the load/unload test, that is, 100 times, 200 times, 500 times, 2300 times, 5000 times, 12000 times, 14700 times and 20600 times after initiation of said test.

The optical disk of the present invention provided at predetermined portions with a lubricant layer comprising silicone grease (called also a silicone grease layer) was allowed to stand at 80°C/dry for 6000 hours, and the optical disk thus treated was then put to the load/unload test 25000 times, whereupon no trouble such as poor loading performance occurred at all in the same manner as mentioned above. The hub portion was visually inspected in the middle of the load/unload test in the same way as above, whereupon no trouble was observed.

Further, the optical disk provided at the predetermined portions with the silicone grease layer was allowed to stand at 80°C/RH 85% for 300 hours, and then put to the load/unload test in the same way as above, whereupon no stress crack of the hub of the optical disk occurred and no such poor loading performance as the optical disk runs idle to make noise or the inner peripheral surface of the hub is shaved was observed.

It is needless to say that the present invention is in no way limited to the examples mentioned above and it will be understood that variations and modifications can be effected within the spirit and scope of the invention. For example, various lubricants other than those used in the foregoing examples may be used,

4. The hub for optical disk as claimed in any of claims 1 to 3 wherein the opening edge of the center hole of said hub is chamfered.

5. An optical disk provided with a hub having a center hole into which a spindle of an optical disk driving device is inserted, wherein a lubricant layer is provided in an opening edge of the center hole of the hub or in the vicinity of said opening edge.

6. The optical disk as claimed in claim 5 wherein the lubricant layer is formed from a lubricant selected from among silicone oil, silicone grease or silicone oil compound.

7. The optical disk as claimed in claim 5 or 6 wherein the lubricant layer has a thickness of 1 to 50,000 Å.

8. The optical disk as claimed in any of claims 5 to 7 wherein the opening edge of the center hole of said hub is chamfered.

9. The hub as claimed in any one of claims 1 to 4, wherein said hub comprises a metallic member capable of being attracted by a magnet member provided on a turn table of a driving device and a resin body having a center hole for inserting a spindle of the driving device, and an inner peripheral portion and the opening edge of the center hole is made of resin.

10. The optical disk as claimed in any one of claims 5 to 8, wherein said hub comprises a metallic member capable of being attracted by a magnetic member provided on turn table of a driving device and a resin body having a center hole for inserting a spindle of the driving device, and an inner peripheral portion and the opening edge of the center hole is made of resin.

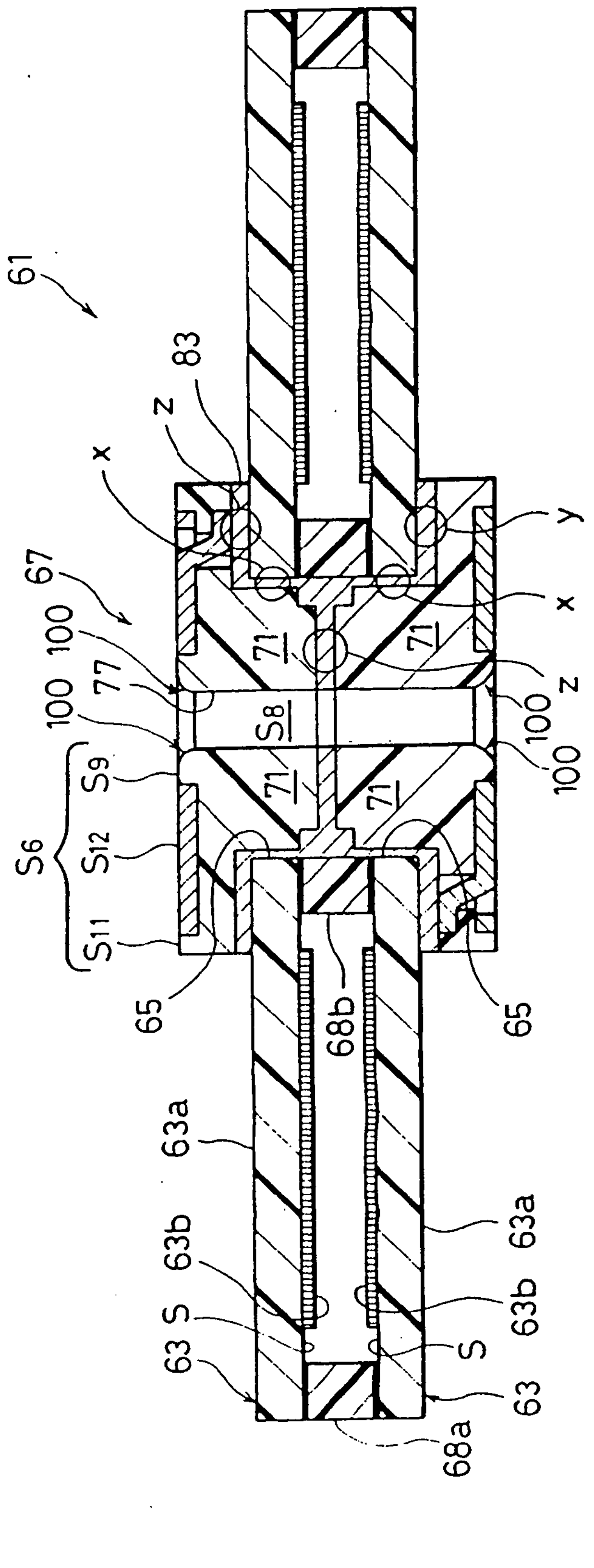
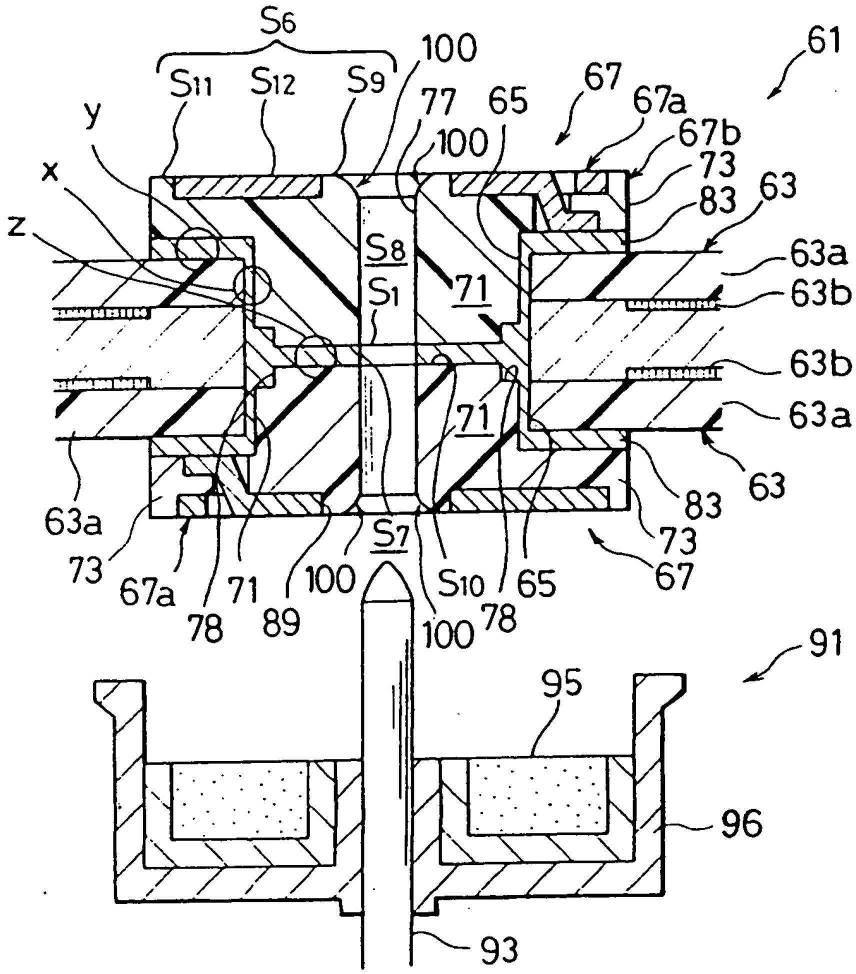


Fig. 2

Fig. 5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S11
S12
S9
100
61
67
67a
67b
77
65
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63b
S8
71
S1
63b
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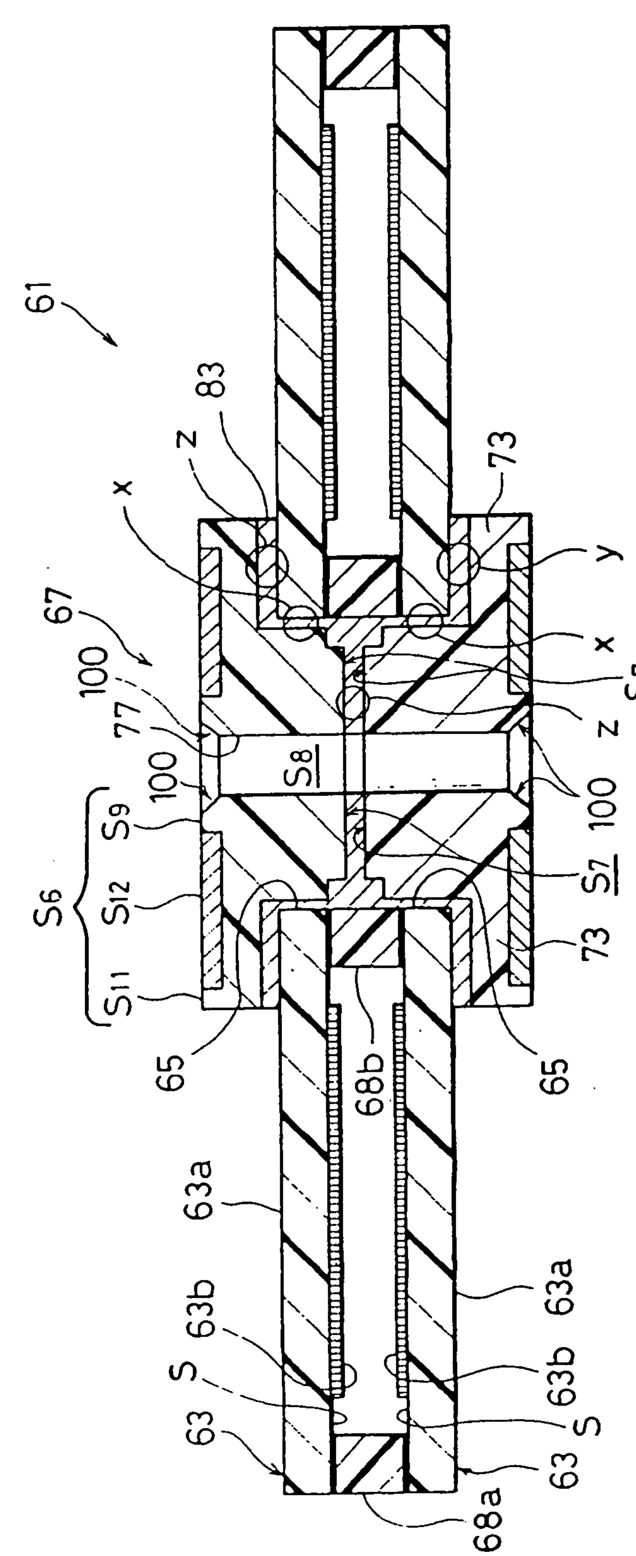
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S6
S12
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Fig. 7

Fig. 9

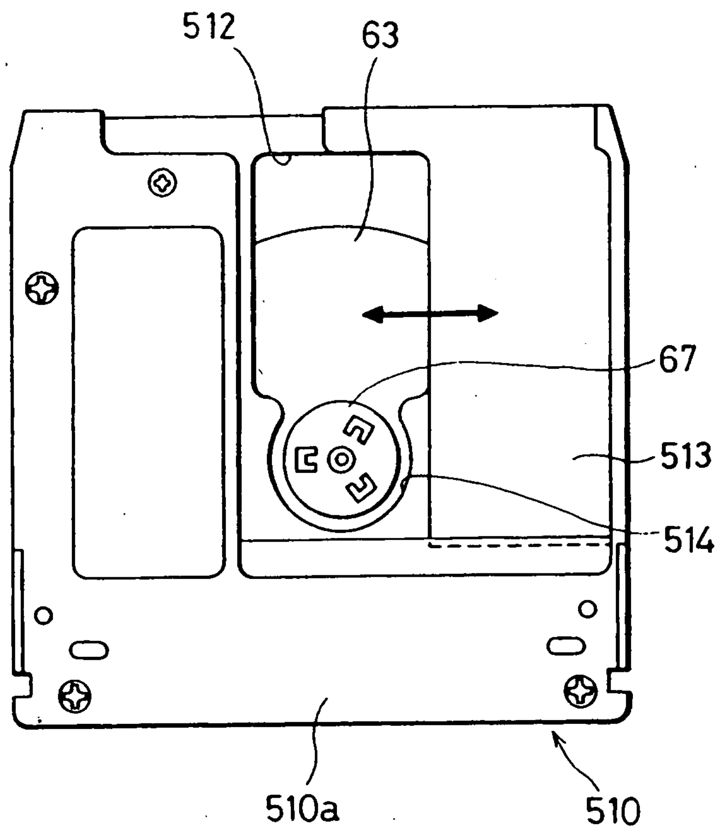

Fig. 12(a)

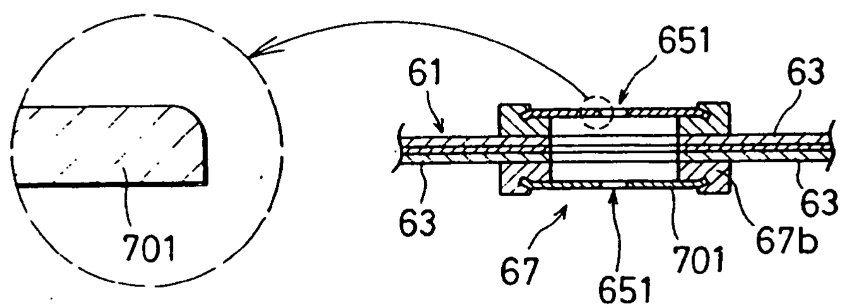

Fig. 12(b)

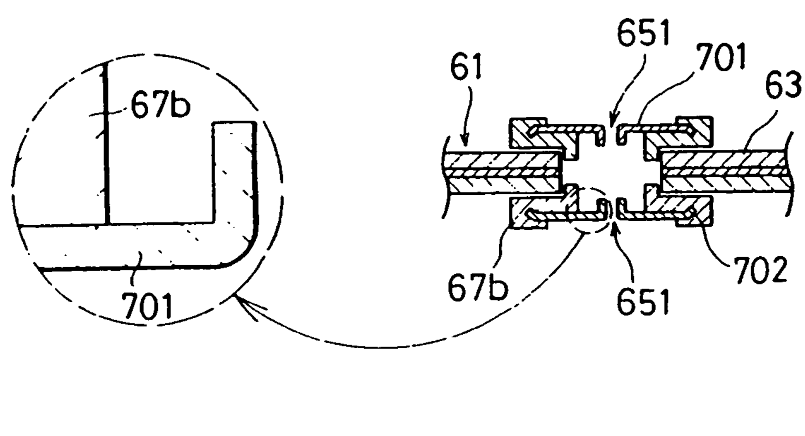

Fig. 14

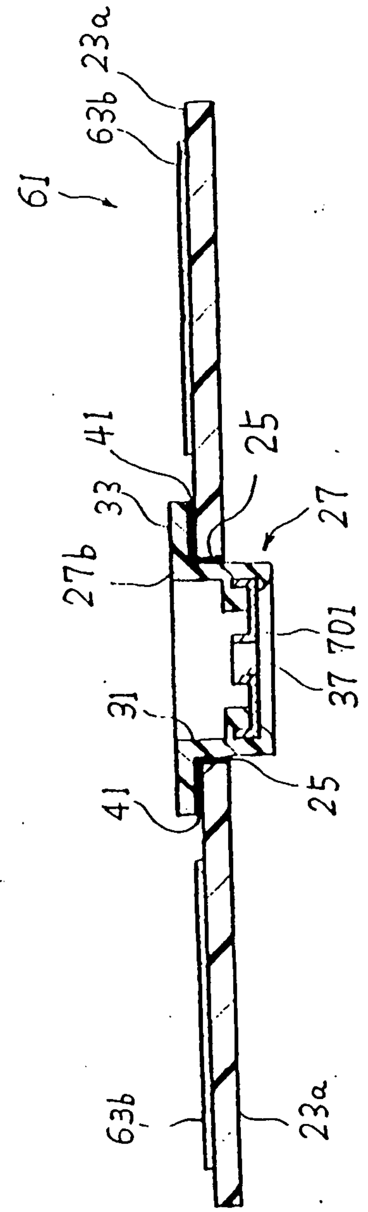

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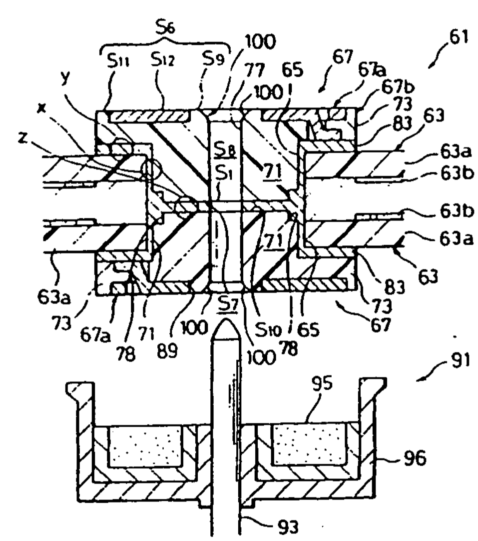
Fig. 5



EP 0 488 388 A3